# The Evaluation of the Impact of New Technologies for Medium-Duty Parcel Delivery Trucks on Fuel Consumption

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# Objective

**Medium-duty vehicles include a wide range of vehicle types and vocations, which require a thorough understanding of all aspects of advanced vehicle technologies**

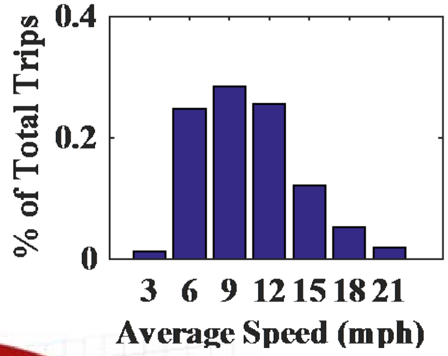
1. Evaluate impact of new technologies on fuel saving
2. Explore the most favorable driving routes on which to adopt the advanced technologies
3. Provide unbiased, aggregated results to help vehicle manufacturers improve their design and fleet managers make informed vehicle purchasing decisions

# Background & Introduction

1. **Four parcel delivery trucks—diesel conventional, gasoline conventional, diesel hydraulic hybrid vehicle (HHV), and diesel electric hybrid vehicle (HEV)—were modeled and validated on FASTSim using chassis dynamometer test data.**
2. **Four technologies—rolling resistance (RR), aerodynamic drag ($C_d$), truck weight, and hybridization—were evaluated.**
3. **1,290 vehicle-days were used to support this research.**


# Outline

1. **FASTSim vehicle models**



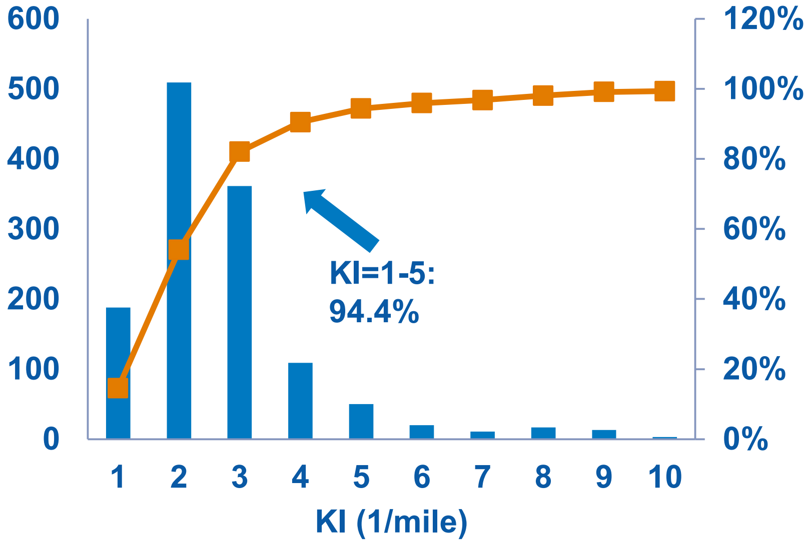

2. **Statistics of trip characteristics**
3. **Results analysis**
   - Impacts of new technologies on fuel savings
   - Most favorable driving routes on which to adopt the new technologies
   - Upfront cost to achieve cost effectiveness
4. **Conclusions**

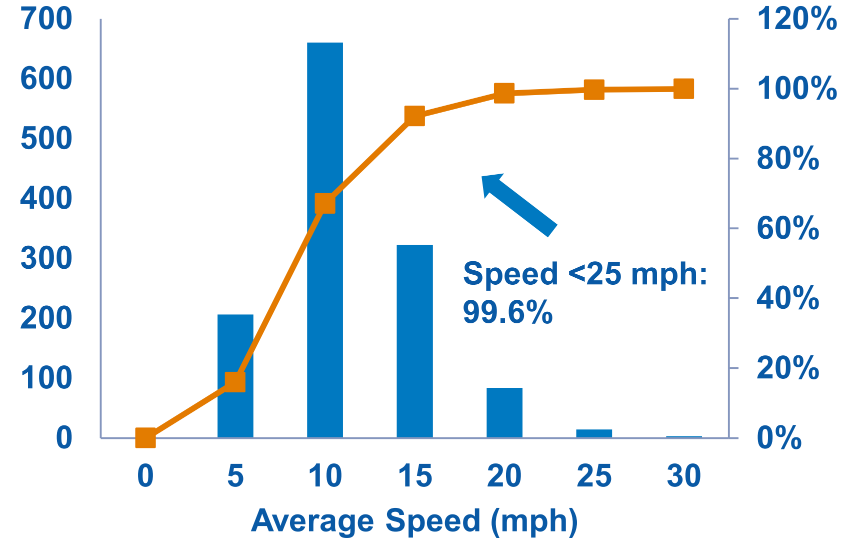
# Truck Models

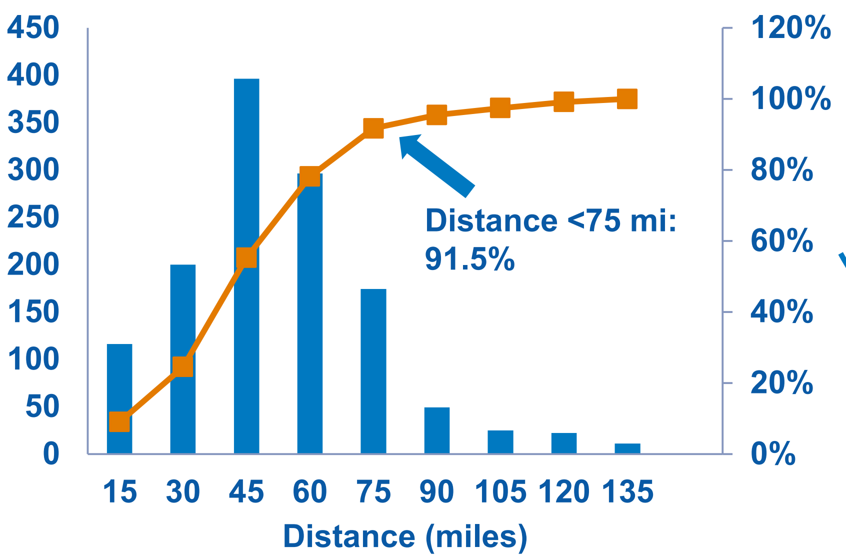
| | Engine (kW) | Weight (kg) | Coeff. of RR | Coeff. Of $C_d$ | Frontal Area ($m^2$) |
|---|---|---|---|---|---|
| **Diesel Conv.** | 149 | 6,990 | 0.0071 | 0.71 | 6 |
| **Gasoline Conv.** | 223 | 6,423 | 0.0092 | 0.7 | 6 |
| **Diesel HHV** | 209 | 8,171 | 0.0092 | 0.7 | 6 |
| **Diesel HEV** | 149 | 7,375 | 0.0092 | 0.7 | 6 |


| | Cycle | ReFUEL MPG | FASTSim MPG | Difference (%) |
|---|---|---|---|---|
| **Diesel Conv.** | **NY Comp** | 7.15 | 7.47 | 4.46 |
| | **HHDDT** | 11.47 | 10.89 | -5.06 |
| | **CSHVC** | 9.48 | 9.46 | -0.21 |
| | **BCC** | 8.52 | 8.44 | -1.02 |
| **Gasoline Conv.** | **NY Comp** | 5.77 | 5.36 | -7.26 |
| | **HHDDT** | 9.18 | 8.74 | -4.78 |
| | **CSHVC** | 7.85 | 7.32 | -6.75 |
| | **BCC** | 6.54 | 6.97 | 6.53 |
| **Diesel HHV** | **NY Comp** | 10.84 | 11.13 | 2.67 |
| | **HHDDT** | 11.28 | 11.46 | 1.60 |
| | **CSHVC** | 12.82 | 12.28 | -4.24 |
| | **BCC** | 10.19 | 10.53 | 3.35 |
| **Diesel HEV** | **HTUF** | 10.00 | 10.05 | 0.46 |
| | **HHDDT** | 10.50 | 10.92 | 4.00 |
| | **NY Comp** | 8.81 | 8.66 | -1.70 |

# Statistics of Trip Characteristics



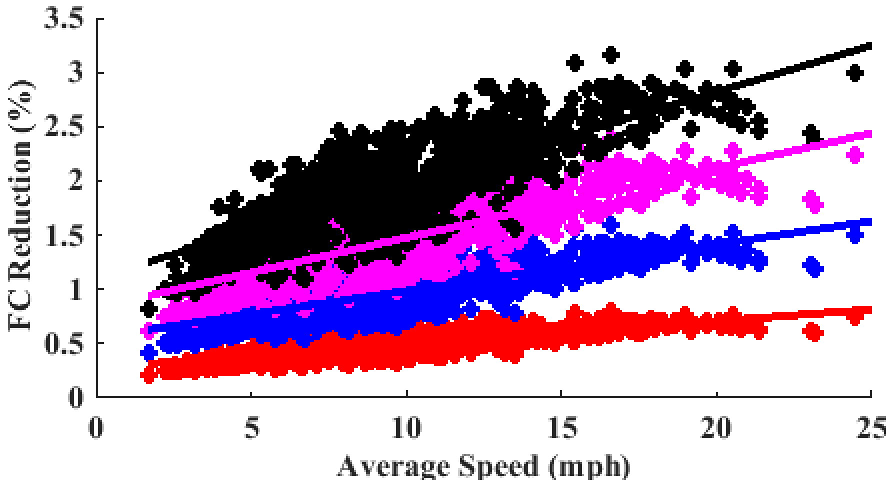



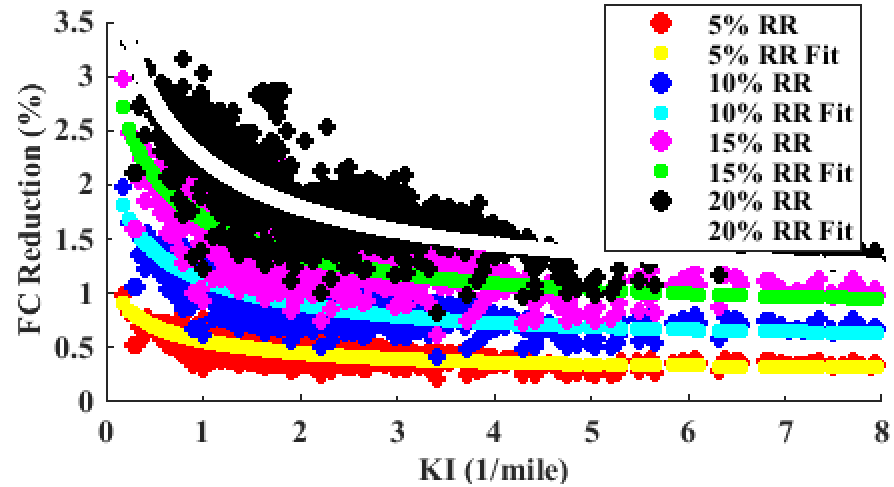



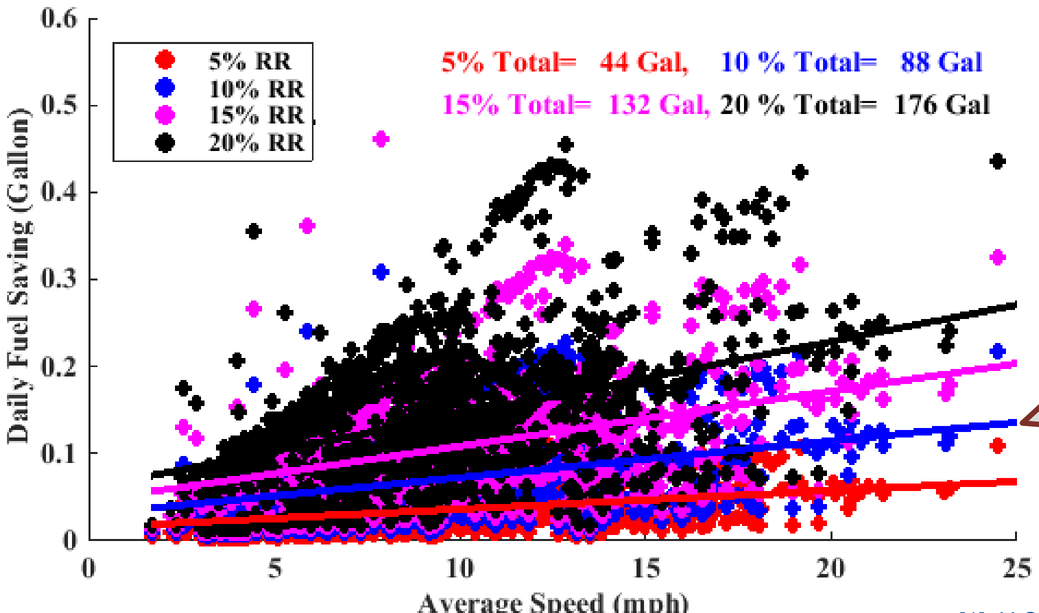

- Over 90% of the trips have a kinetic intensity (KI) range from 1 to 5, an average speed less than 25 mph, and a daily travel distance less than 75 miles.

KI=Kinetic Intensity

# Fuel Saving with Reduced Rolling Resistance



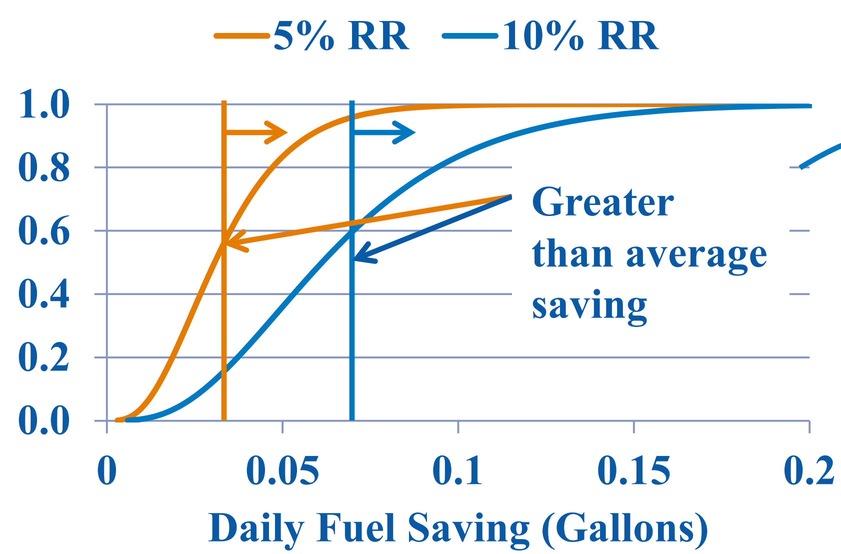



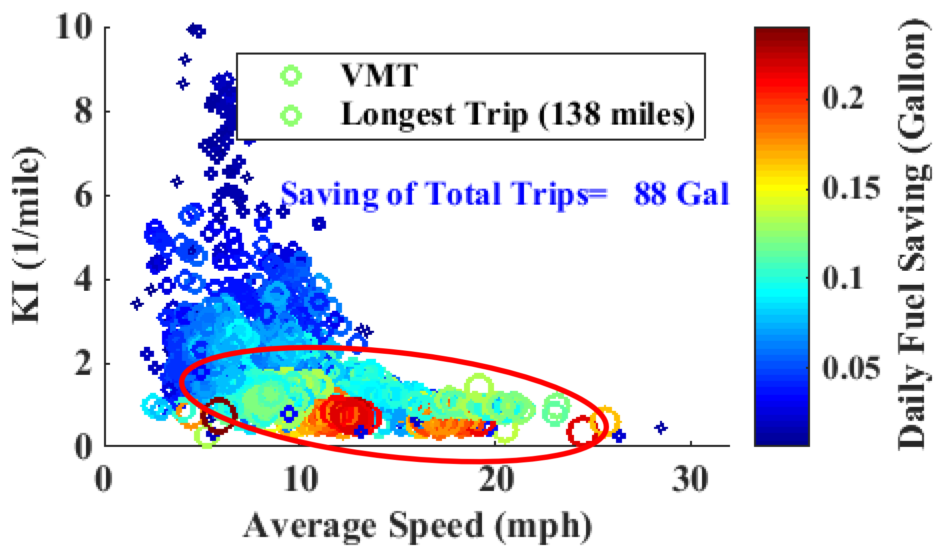

- **256 gallons lifetime fuel saving**
- **The cost effectiveness of the upfront cost is less than $921, assuming $3.60[1] projected diesel price**

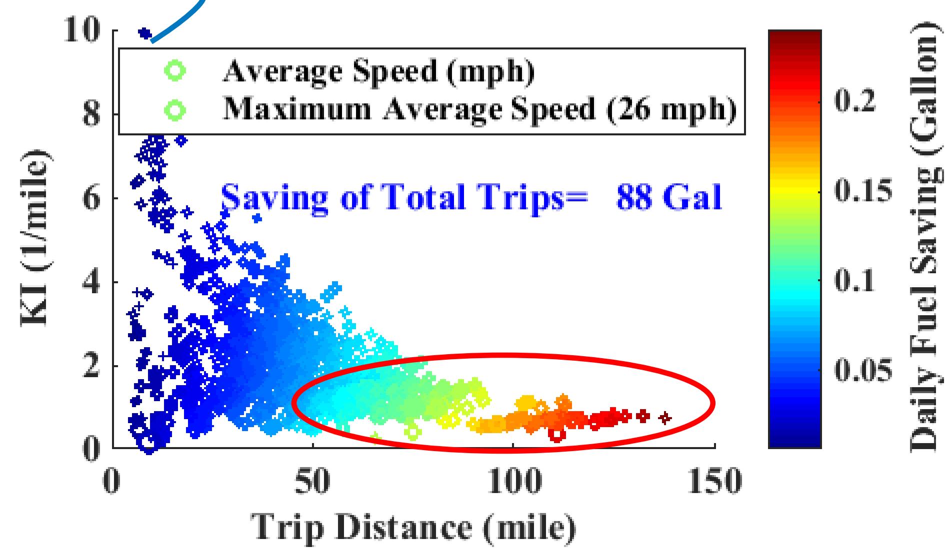
[1]. U.S. Energy Information Administration, "EIA Annual Energy Outlook 2010 with Projections to 2035," DOE/EIA-0383(2010).

# Distribution of Daily Fuel Saving and Favorable Driving Trips with Reduced Rolling Resistance

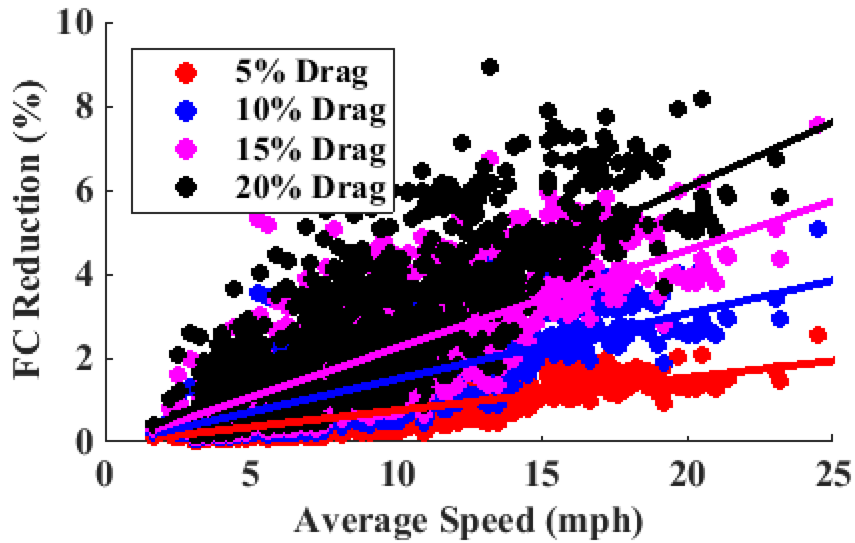


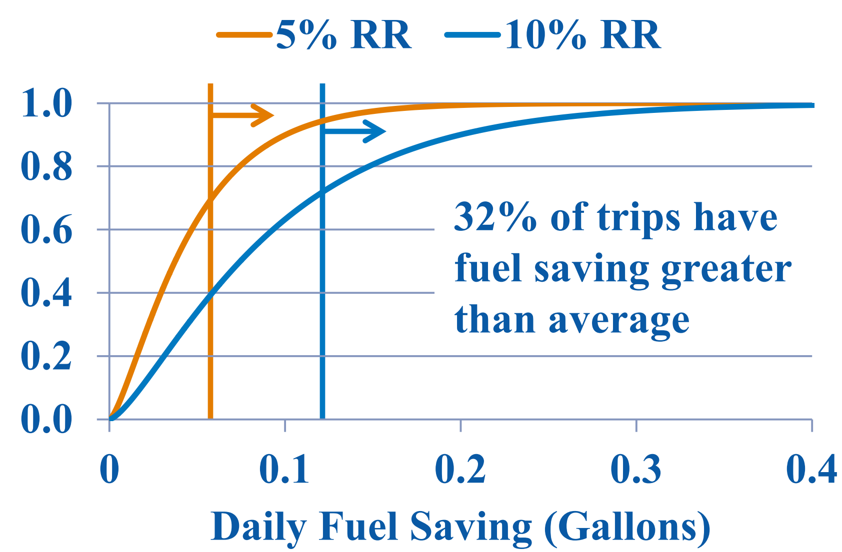

- 40% trips have fuel saving greater than average
- Adopting low rolling resistance should start with trucks driving on long distance, low KI, and high-speed trips

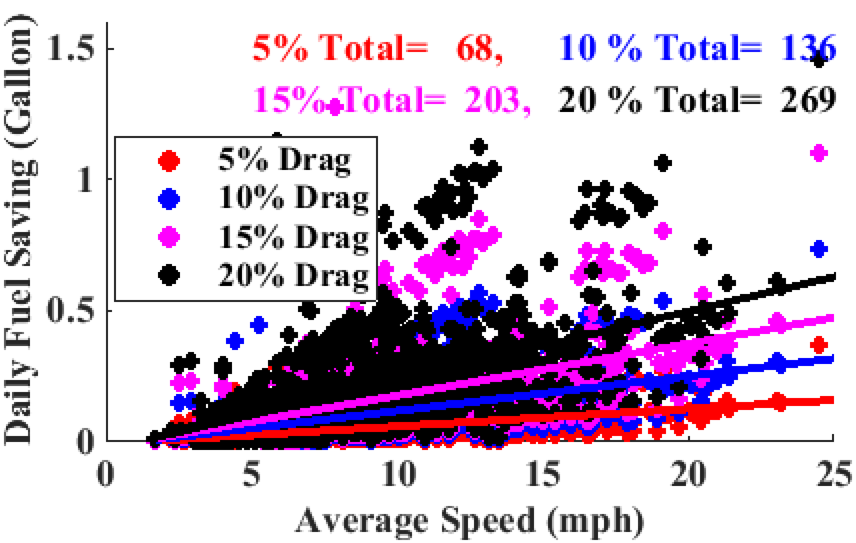


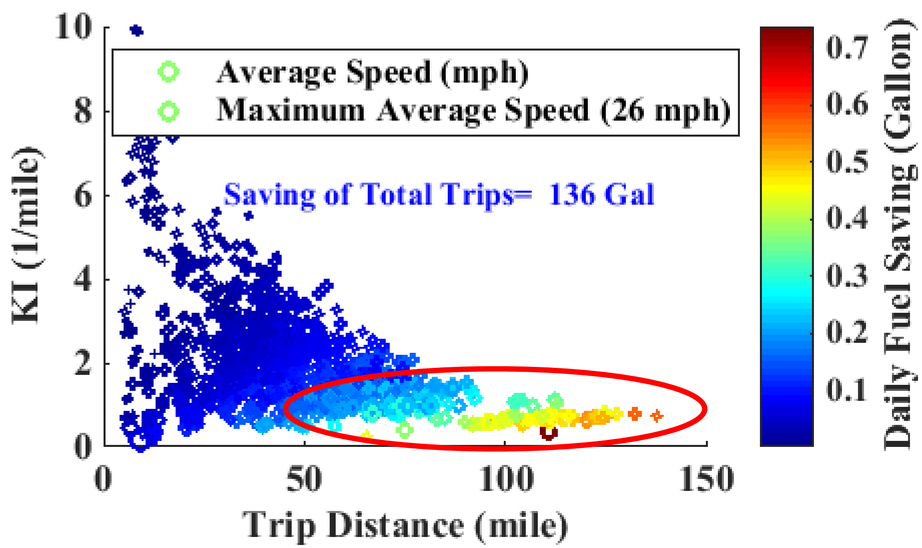



# Daily Fuel Saving and Favorable Driving Trips With Reduced Aerodynamic Drag

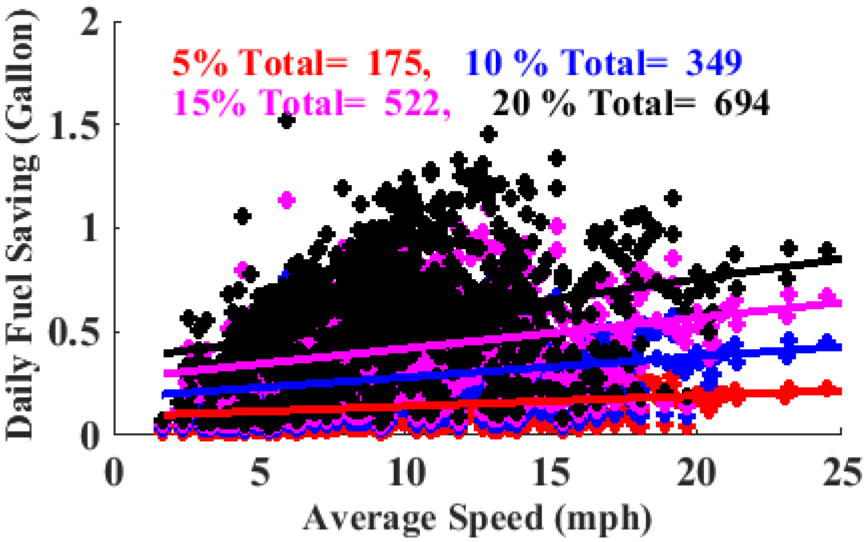


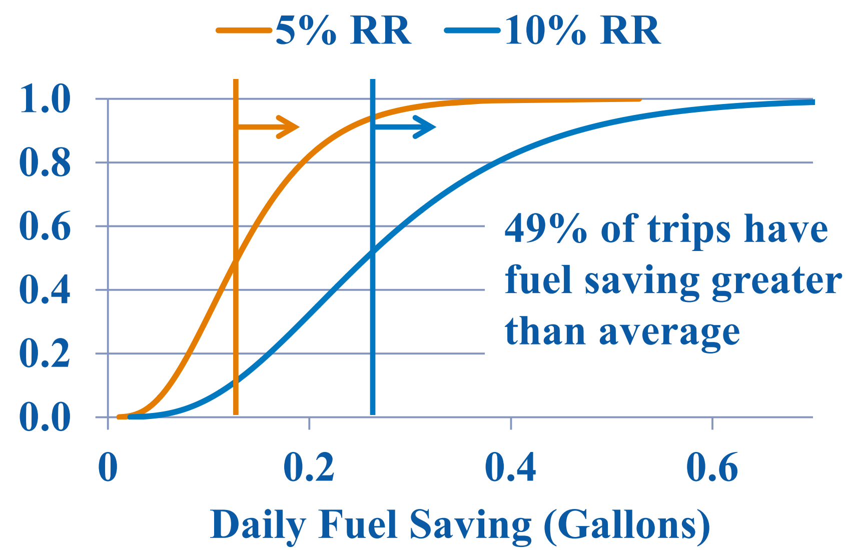



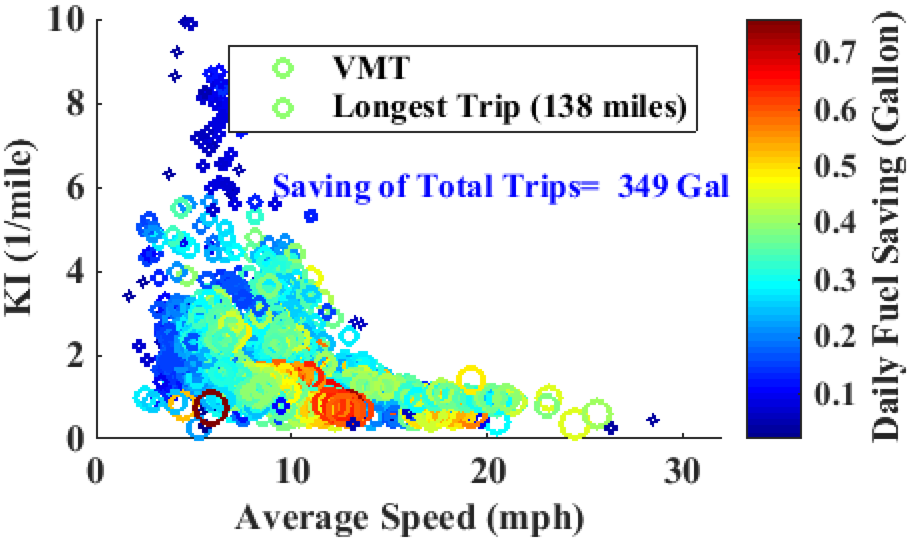



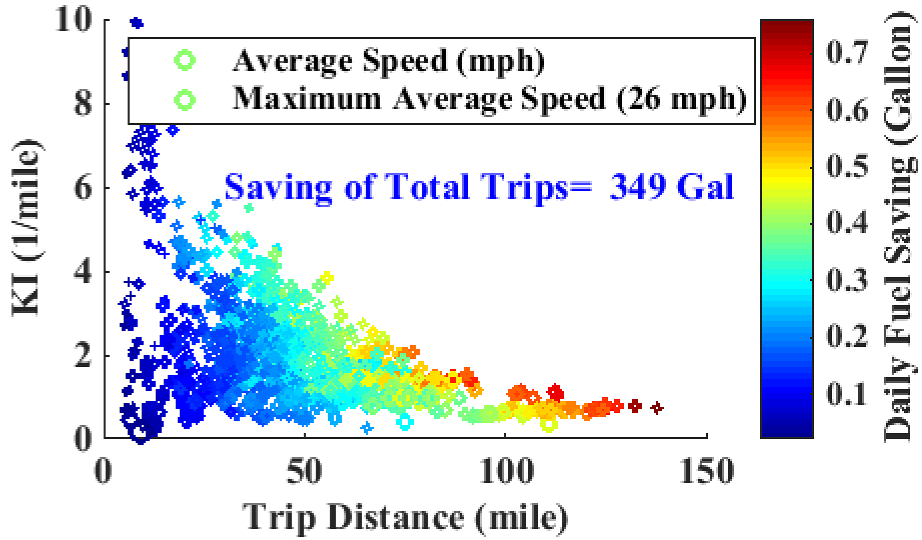



# Daily Fuel Saving and Favorable Driving Trips with Reduced Weight

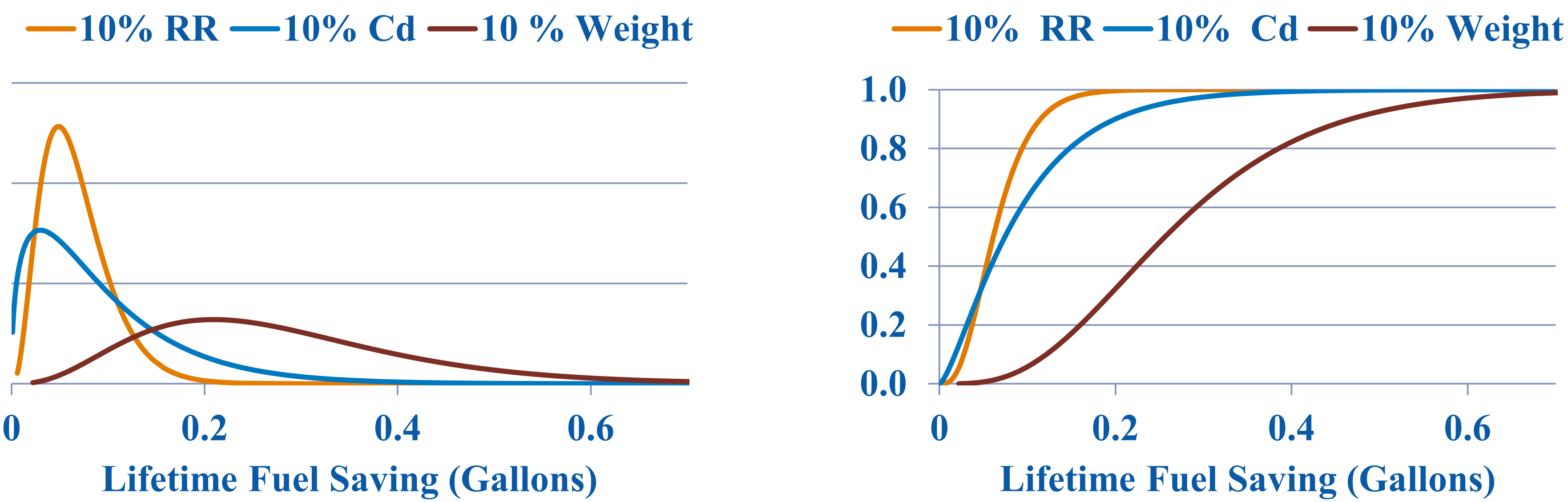


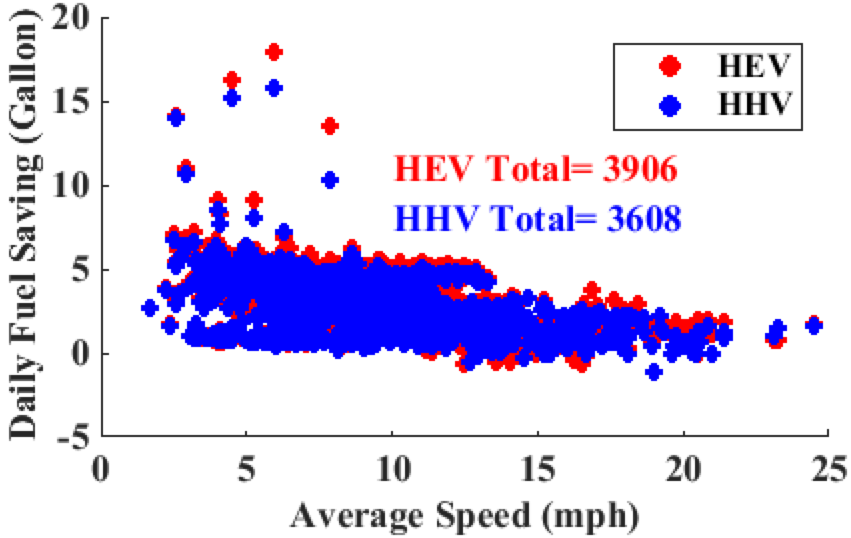



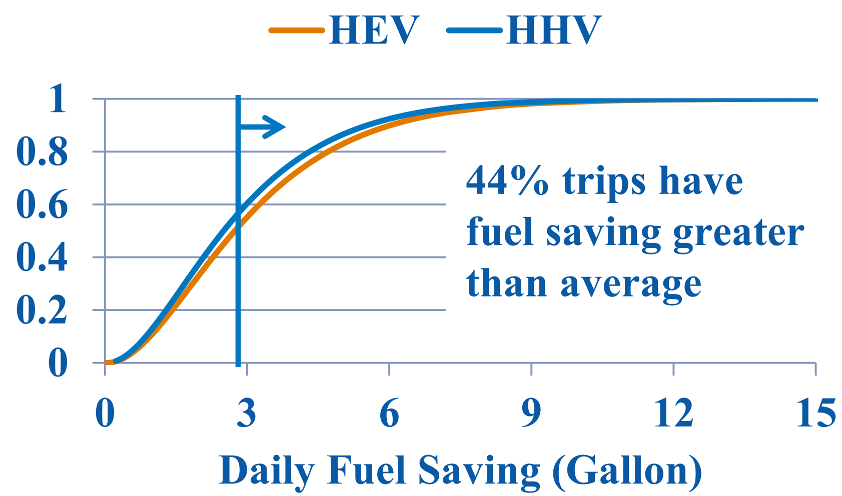
# Daily Fuel Saving With 10% Reduction in Three Technologies

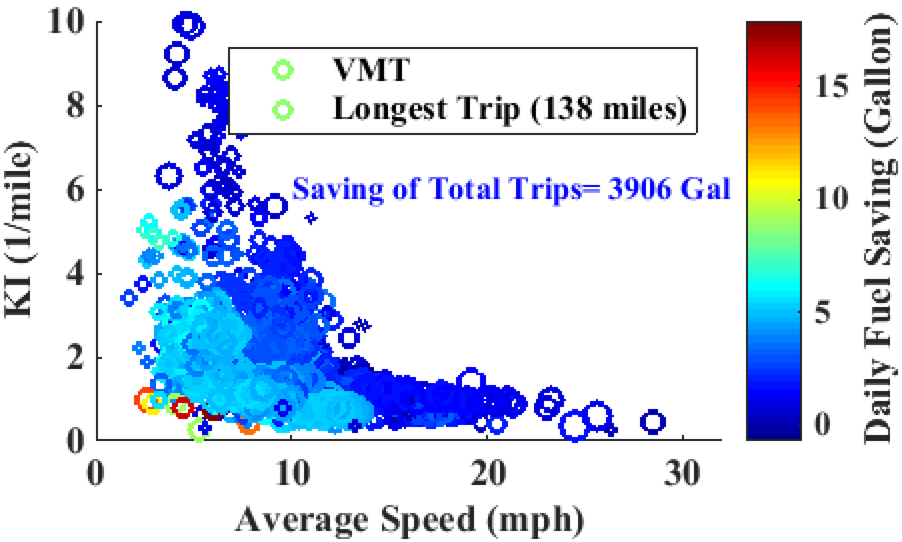


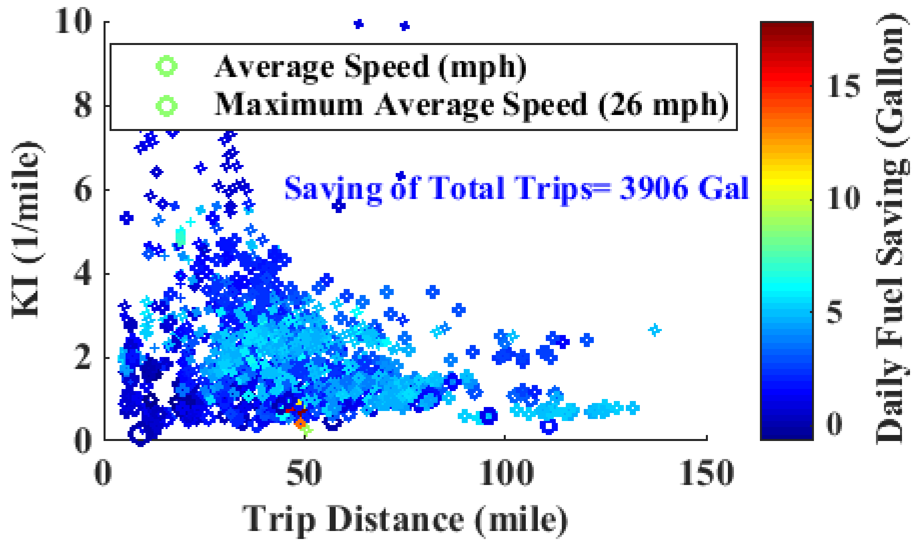

- The fuel savings are largest for a reduction in weight and least with a reduction in rolling resistance
- Fuel savings due to reduced rolling resistance are larger than the same amount of reduction in aerodynamic drag at low speeds

# Daily Fuel Saving With Hybridization



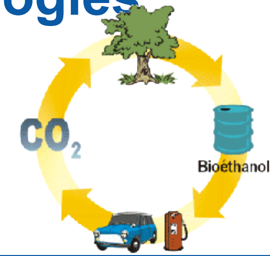



# Conclusions

- **The impacts of new technologies on fuel saving were explored**
  - Up to 2%, 4%, and 6% reductions in fuel consumption were achieved when reducing rolling resistance, aerodynamic drag, and curb weight by 10%, depending on the characteristics of driving trips
  - The fuel savings of hybridization surpassed that of reductions in other new technologies
- **Most favorable driving routes on which to adopt new technologies were recommended**
  - Trips with high speed, long distance, and low KI were proposed to adopt low rolling resistance and aerodynamic drag
  - Trips traveled at high speed and acceleration over a long distance would be good candidates on which to use lighter-weight trucks
  - Trips with low average speed have the largest benefit with hybridization
- **The study suggested that, if the cost of the new technologies is known, depending on the circumstances, it may be more cost effective to adopt one technology, or it may be more beneficial to take on another**



# Questions?

# Acknowledgments

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